Everything from Scratch: Practical Ideas in an Organization without a Concept of Process Improvement

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In this experience report, I present practical ideas to establish a new role, to improve product development teams, and to proceed company-wide problem-solving from scratch in the very strongly technology-oriented and fast-growing company without a concept of process improvement and clear supporters.

LINE Corporation [1] has been growing very rapidly and globally. However, the company had been struggling with increase of outages and they had given negative impacts to users and company's profits simultaneously. Since I joined LINE Corporation as the first member of “SET” (Software Engineer in Test) [2] in 2017, I and our team have been solving a wide variety of problems including reduction of outages, innovation in testing tools, onboarding, and so on by combining technical solutions and Agile methodologies based on my experiences as an Agile Coach. We have been pursuing "best for our users and business" fiercely and relentlessly with a series of experiments. Now, some teams in our company utilize our ideas that we reflected, experimented, and succeeded from scratch.

# Introduction

"LINE" is a free message, voice calls and video calls service for smartphones that has released since 2011. Our company name is derived from this service [3].

After the first release of “LINE”, LINE Corporation has increased its users and messages transferred rapidly and globally. Especially, its high-quality sound, and the "sticker" feature that we can send a variety of rich emoticons as a message attracted a lot of users.

For adapting to the rapid growth of LINE, we have been improving LINE's architectures and code base iteratively. We chose Microservice Architecture [4] to earn scaling out, independent development, and fast delivery capabilities.

However, increase of Microservices has been causing increase of outages simultaneously. The more we expand business areas like fintech, the more troubles at Integration Points [5] among each Microservice increase. Negative impacts to LINE users and company's profits became measurable in 2017.

LINE Corporation had struggling with solving these critical problems for themselves but failed. Because LINE Corporation was a strongly technology-oriented company and it didn't have a concept and experience of process improvement at that time. There were very few leaders and supporters to improve this situation.

Therefore, LINE Corporation had started looking for proper leaders externally. Evaluated over five years of my experiences and achievements as an Agile Coach and Test Automation engineer, I joined LINE Corporation as the first member of SET in September 2017.

# ESTABLISH SET ROLE BY ATTRACTING DECISION-MAKERS AND COLLEAGUES

## CHALLENGES

After joining LINE Corporation, I faced with tons of challenges to start my work as SET.

The biggest challenge was that a sense of crisis about increase of outages was not shared among employees. Only a few decision-makers like senior managers and executives were acknowledged and concerned about emergencies to solve negative impacts of outages to LINE users and company's profits as rapidly as possible.

Additionally, there were no clear ideas and solutions for increase of outages in the company. LINE Corporation had not experienced process improvements until then because of its very strongly technology-oriented fashion. Wide adoption to Microservice Architecture became a barrier to consider solutions beyond each service or technical silos.

Moreover, there were no shared understanding and consensus about SET role among decision-makers. LINE Corporation established SET job without clear objective, missions, and responsibilities. The company's intention at that time was very naive that just introducing Test Automation to the company might solve something.

## ACTIONS

My focus was to obtain consent from decision-makers and colleagues by discovering their real concerns and providing solutions iteratively and incrementally.

### SHARE A SENSE OF CRISIS BY VERBALIZING REAL CONCERNS

I thought not only decision-makers and colleagues but also, I should know real problems LINE Corporation was facing with in a knowledgeable way. It was time to follow an ancient saying by Sun Tzu: "If you know the enemy and you know yourself, you will have almost 100 battles". From my experiences of Agile, I thought "Product Discovery" [6] might fit well.

Therefore, at first, I talked developers, QA persons, Product Managers, senior managers, and executives to hear their concerns and troubles directly. Through these conversations, I acknowledged that they had lots of non-verbalized problems. Additionally, I got that there were no persons who could verbalize these problems and share with other colleagues.

Next, I focused on helping colleagues to verbalize their concerns and to share them with other colleagues.

I investigated our services and products. I utilized "SonarQube" [7], a static code analysis tool, to know the code coverage and technical debts for each service. I also implemented and run some of unit and integration test scripts to know real behaviors of the products. Test scripts are good for understanding software under test [8] and finding problematic services.

Additionally, I focused on "outage reports". "Outage report" is a term which means both a published report and a postmortem meeting in our company. From these reports, I acknowledged that 1) reports were too technical to know impact on sales and profits, 2) reports didn't consider clear goals and actions to prevent the outages, and 3) "Channel Gateway", an aggregation service of our APIs towards external users, was the most problematic products.

After investigating services and outage reports, I could verbalize colleagues' concerns as follows: 1) increase of Channel Gateway's outages was the most critical issue that was giving negative impacts to external users, 2) failure detection of Channel Gateway took an average of one week and it was not acceptable for a Product Manager, and 3) testing APIs was insufficient in almost all of services because few persons knew how to test APIs programmatically. I shared these verbalized ones and agreed them with colleagues, managers and executives.

### GIVE IMPACTS CONTINUOUSLY TO INCREASE SUPPORTERS

For getting support from colleagues and decision-makers to proceed with radically new actions, I tried to "give impacts" [9] constantly to them.

From the first week I joined LINE Corporation, I achieved something and shared them with coworkers and decision-makers every week. Especially, I focused on providing working software, executable ones, and quantitative information.

Here is a list of achievements for my first ten weeks.

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| --- | --- |
| Week | Achievements |
| Week 1 | Started writing test scripts to understand services/products |
| Week 2 | Proposed first idea of SET activities to decision-makers |
| Week 3 | Built mechanism to run and report static code analysis regularly |
| Week 4 | Shared with developers how to build static code analysis |
| Week 5 | Proposed milestones of activities to decision-makers |
| Week 6 | Agreed with proposals/milestones with decision-makers |
| Week 7 | Collected information and tools of QA/Tests in one place |
| Week 8 | Implemented failure detection mechanism for Channel Gateway |
| Week 9 | Guided to start regular meetings with developers and QA persons |
| Week 10 | Started solving problems by developers step by step |

Figure 1. The list of achievements for my first ten weeks as SET.

When I gave impacts, I utilized "Three KPIs": Sales, Profit, and Employee Satisfaction. It is that my former supervisor told me as a way to measure every business. For example, my first proposal of SET activities to decision-makers included reducing MTTR (Mean Time to Repair) of Channel Gateway by implementing proper failure detection mechanism for reducing negative impacts to external users. Additionally, I not only reported results of static code analysis, but also shared with developers how to build static code analysis mechanism from Employee Satisfaction aspect.

As a result, many developers started using my impacts like static code analysis mechanism and giving me concrete advices about problematic points of architectural design, operational difficulties, and so on. Their advices became good information sources to communicate with decision-makers. Additionally, decision-makers started taking time to define SET role with me. They couldn't ignore my impacts and developers' supports to SET.

### ITERATIVE AND INCREMENTAL CONSENSUS

In parallel with giving impacts, I built consensus on SET role with decision-makers gradually. From the first week I joined LINE Corporation, I started proposing ideas of SET; objective, missions, responsibilities, solutions, and milestones; iteratively based on gathered information I verbalized and got from colleagues.

This phase was analogous to start-up business or building new services. Through discussions, we corrected ideas of SET role, and built feeling of trust each other step by step. It was a weekly cycle of build-propose-learn. I named it as "Iterative and Incremental Consensus".

As a result, within forty-five days since I joined LINE Corporation, we agreed on 1) making failure detection faster and reducing MTTR by utilizing Test Automation techniques, 2) increasing API test scripts, and 3) focusing on Channel Gateway at first as SET role, goals, and milestone. It was a result from scratch.

## RETROSPECTIVE

Establishing SET role in LINE Corporation was analogous to start-up business or building new services to me.

In an organization without a concept of process improvement, showing concrete examples to improve small things step by step could give impacts to the organization positively. Verbalizing colleagues' concerns as Product Discovery became good information sources. Additionally, providing achievements and building feeling of trust as impacts worked for getting support from colleagues and decision-makers. Moreover, Iterative and Incremental Consensus was effective for collaboration and quick agreement on totally new ideas with decision-makers. Through these activities, Three KPIs worked as common criteria for improvements among colleagues, decision-makers, and I.

# INNOVATE SOLUTIONS AND PROCESSES BY EXPERIENCING HARDSHIPS TOGETHER

## CHALLENGES

After establishing SET role, I started actions as SET by obtaining consent from colleagues and decision-makers. After six months, we hired new SETs and formed a team of SET. I became the leader of the team. I thought we could proceed our activities more quickly and widely, however, we faced with some new challenges.

The biggest challenge was that the failure detection mechanism we implemented for Channel Gateway didn't become established in the team.

Based on the first agreement with decision-makers, we built a failure detection system for Channel Gateway to reduce its MTTR. We implemented the system by combining Test Automation techniques and Continuous Integration (CI) servers. We implemented test scripts for its APIs. Additionally, we configured CI servers to run these test scripts periodically on both development and production environments. Moreover, we configured servers to notify errors and/or failures detected by running test scripts to members of Channel Gateway's team (hereinafter called "the team") in a minute or two via Slack [10]. We used JUnit and Spring Boot [11] to implement test scripts to meet the team's skill sets, and to make the team members implement test scripts by their own.

After providing the system including manuals to the team, it worked well for the first two months. It made failure detection dramatically from one week to one hour. Additionally, some team members started implementing test scripts. However, they became ignoring notifications from the system soon without clear reasons.

Soon we hypothesized that we couldn't approach the team's real problems properly due to lack of knowledge of their contexts deeply. Just providing tools and guidelines as consultants won't work in this case. We often got requests from lots of teams to provide standardized tools, guidelines, and reference implementations. However, we never saw that they worked fine and solved their core problems because they tend to be far from the team's real needs and contexts.

## ACTIONS

Our choice was to join the team and work together for understanding the team's contexts, finding proper solutions, and committing the team and solutions more.

### DISCOVER THE TEAM'S REAL NEEDS AND CONTEXTS REMOTELY

At first, we utilized Product Discovery again. We started direct conversations with the team members to hear and verbalize their real concerns, needs, and contexts. The team and we SET team talked every day as deeply as possible by using video conference system because each team has been working at different offices. Additionally, we used Slack to fill in gaps in oral communication. Moreover, we discussed with the team's Product Manager if he came to our office.

Through these discussions, we understood that test scripts written in JUnit were hard to read, write, and maintain for the team members. Additionally, we knew that the team members didn't read manuals we provided. Therefore, the team and we SET team needed to find proper ways to implement test scripts and to be accustomed to using the failure detection system.

### REBUILD THE FAILURE DETECTION SYSTEM WITH KARATE

Next, the team and we SET team started to look for and evaluate proper tools which would meet our needs and preferences together.

After one month's research and evaluation, the team and we SET team agreed on using "Karate" [12]. Karate is an open-sourced framework which focuses on API testing. It provides features that make testing RESTful APIs, Thrift [13], and gRPC [14] easier. We can implement test scripts with Gherkin syntax [15] and BDD (Behavior-Driven Development) [16] style. The team members favored its readability, maintainability, and extensibility points.

After the decision to use Karate, the team and we SET team started rewriting all test scripts from JUnit to Karate collaboratively. At first, we SET team implemented examples, provided them to the team members, and taught the team members points to use Karate. Soon after these preparations, the team members became able to implement test scripts by their own.

It took three months to rewrite all test scripts from JUnit to Karate. However, just rebuilding the failure detection system was not enough became it established in the team.

### EXERCISE PROCESS IMPROVEMENTS WITH THE TEAM

Concurrently to rewriting test scripts, we aimed to teach the team members how to use the failure detection system without manuals and solve problems by working together. Therefore, the team and we SET team had been tackling with wide variety of testing issues together; the architecture and the product designs that were hard to test, preparation of test data, extension of Karate features, and so on. Additionally, we had taught the team members how to set goals and milestones, clarify objectives, prioritize APIs to test, provide quantitative information to users, and so forth. For example, we told the team members to order APIs by frequency of outages and monetary impacts to users as priorities to test. In other words, we showed how to apply Three KPIs concretely.

After three months' collaborative work, finally the failure detection system with Karate became established in the team. Now all of the team members including the Product Manager are writing and maintaining test scripts with Karate routinely without our support.

Additionally, the team became self-organized one. They became able to define goals and milestones, prioritize their tasks based on business values, and collaborate with related teams by their own without our help.

Moreover, business impacts started to emerge. They reduced over thirty percent of outages after the above actions. Now many product development teams use the team as a reference of improvements.

## RETROSPECTIVE

Experiencing hardships with the product development team together is a key to an innovative solutions and processes.

In Channel Gateway, we could understand the team's contexts deeply by working together. We made the failure detection mechanism become established in the team based on this information. However, I don't think of just working collaboratively with the team is enough to understand the team's context. The experience of struggling with the same problems and solving them together creates "compassion". I think "compassion" is a key driver for problem-solving over difference of contexts. Incidentally, the English word "compassion" derives from Latin's "compatio", which means "suffer with".

After this experience, we SET team ruled to work with target product development teams together as the first step. This is our way of problem-solving from scratch.

# TRANSFORM THE ORGANIZATION WITH BUILT-IN EXPERIMENTS AND LEARNINGS

## CHALLENGES

We SET team have been working with three product development teams together as the same as Channel Gateway. We have been finding and solving lots of technical and process issues step by step collaboratively. We believed we were doing well at that time. However, one day, bottlenecks moved and we faced with new urgent challenges.

The first challenge was an emergent necessity of onboarding. In July 2019, two new members joined our team. One member was a mid-career employee who had an experience of client-side Test Automation but less experience of Microservices. Another member was a recent graduate who didn't have any experience and knowledge of Agile and Test Automation. Our team had only three existing members at that time. It was obvious that we needed to stop our actions for a certain length of time until finishing onboarding.

The second one was an acute requirement to reduce MTTR on each Microservice. We had implemented the failure detection system with Karate, CI server, and Slack in Channel Gateway. It had reduced over thirty percent of outages. However, we couldn't have identified the root cause of each outage at that time. A chain of API calls among Microservices was too complicated to identify the root cause. Additionally, rapid growth of our business has been adding complexities continuously. Taking one month or more to identify the root cause had been becoming common.

## ACTIONS

We established new solutions really from scratch by continuous experiments. An essential point to these series of experiments was a built-in learning mechanism in our team.

### LEARNING SESSION FOR ONBOARDING

For proceeding the onboarding smoothly, I, as the leader of SET team, decided to try to train new members during business hours as effective as possible by imitating professional sports and military training. I chose the idea of "Learning Session", a way of study sessions during business hours taught by Chris Lucian at Agile2017 [17].

Here are basic rules in our team. We have been holding the Learning Session for thirty to sixty minutes every day during business hours as a work. We can choose any topics we assume it's effective for our daily activities. Anyone can speak and facilitate the session with Mob Programming way. The most important point is doing with a fun and without criticism.

Through a series of Learning Sessions, we have been learning a wide variety of tools, techniques, Agile methodologies, and so forth that are effective for our daily activities. For example, all of our team members became accustomed to Karate framework. We became able to set up Karate with CI server, implement and refactor test scripts, and teach colleagues usefulness and how to improve API testing with Karate. Now Karate is one of our team's competitive characteristics. Additionally, we have been experimenting Scrum and Kanban to make our team's process improvements second nature. Currently, holding a retrospective meeting biweekly is our key to improving ourselves.

As a result, we smoothly finished onboarding for two newcomers within one month. They became able to release what they implemented to production environment within one week. In other words, they could contribute to our business within one week. Additionally, they became accustomed to getting fast feedbacks by demonstrating what they implemented to users very frequently. It's not too much to say that we scaled out our team by utilizing Learning Session.

### LEARNING SESSION FOR ORGANIZATIONAL PROCESS IMPROVEMENTS

The outcome of Learning Session was not only for smooth onboarding. We found that Learning Session gave three additional impacts to our team and our department.

The first impact was for our evaluation process. Soon after we started Learning Session, we found that holding Learning Session every day is as the same as evaluating each other on a daily basis. On one hand, I, an evaluator, can touch members' activities, achievements, and impediments directly every day. On the other hand, members can show their achievements to me very easily and quickly. Therefore, we don't need to set evaluation meetings only at the evaluation period. We can adjust behavior each other through daily observations and feedbacks to meet the team's objectives. As a result, we could reduce the burden of personnel evaluation dramatically for both an evaluator and a member to be evaluated.

The second impact was the psychological one. Through Learning Session, we learned that we don't need to be perfect because we utilized Learning Session as opportunities of experiments. Additionally, we often drilled trouble shootings and recovering services at Learning Session. We have been reducing psychological pressures as a mechanism. Therefore, our team members became accustomed to trying and proposing new ideas to other teams without fear. I will tell one example of a new idea in 4.2.3.

The third and last impact was the expansion to other teams and our department. In our company, it was common for each team and organization to hide its activities and not to collaborate each other. However, after I published a blog about Learning Session [18], some teams and organizations started Learning Session. Soon we found that they just didn't know how to collaborate each other to solve their problems. After that, not only our department but also our team could know each other's objectives and solutions deeply. I will show one good achievement in 4.2.3.

### ACHIEVE RESILIENCE OF MICROSERVICES FROM SCRATCH

For making the root cause identification on each Microservice of each outage, we invented a totally new solution from scratch. For innovating this solution, we combined what we learned from a series of Learning Sessions.

At first, we started combining Karate framework with Zipkin [19]. Zipkin is an open-sourced tool to visualize the dependencies of Microservices, orders of APIs called, and problems on each Microservices. We aimed at pinpointing the root cause of failures in a fleet of Microservices with Zipkin. We found that one team in our department was utilizing Zipkin through expanding Learning Session. Therefore, we collaborated combining Karate and Zipkin.

Next, we replaced existing reporting function of Karate from scratch. At first, we tried to add Zipkin's "trace id", that tracks APIs called, into Karate's test report. However, after quick investigation, we found it was very difficult from technical aspect. Therefore, we chose to reimplement reporting function with Vue.js [20] from scratch. In this phase, what we learned about Vue.js through Learning Session worked very well.

Our approach was utilizing the idea of observability and monitoring via Test Automation. This new test report could pinpoint which Microservice failed by utilizing Zipkin's trace ids on a screen we recreated from scratch with Vue.js. We named this report as "Sebas Report". The name "Sebas" is derived from a famous butler as the same as Jenkins.

After the release of Sebas Report, we could reduce the root cause identification of Channel Gateway from one month to one hour. Additionally, Sebas Report could save each member and Product Managers' total investigation time drastically because we could pinpoint a team that was responsible for failed Microservice. Moreover, we started promoting Karate and Sebas Report company-wide and recommending focusing more on resilience of Microservices rather than detecting bugs and solve them beforehand from economic efficiency aspect. Now we assume Sebas Report as a way of achieving resilience of Microservices.

By the way, for comparison, the newcomer of a recent graduate led over sixty percent of implementations of Sebas Report.

## RETROSPECTIVE

Learning Session gave our team, other teams, and other organizations chances and hints to overcome lack of a concept and experience of process improvement in our company.

At first, we utilized Learning Session as a way of smooth onboarding. However, the impact of Learning Session was not limited only in our team. It became an important key factor for collaborations from scratch in our company. Additionally, these new collaborations and what we learned through Learning Session led to an invention of "Sebas Report".

Finally, our company achieved a way how to tame the complexity of Microservices and its outages with collaborations and process improvements from scratch. Our company earned the experiences of process improvements.

# LESSONS LEARNED

Through a series of experiences I explained, we learned three key success factors.

At first, Agile methodologies and experiences worked well for establishing SET role in LINE Corporation. Especially, verbalizing stakeholders' concerns and sharing them with decision-makers by Product Discovery was the most important key element in this success. Additionally, attracting decision-makers and colleagues by giving impacts continuously was very effective to start totally new actions.

Second, we could provide innovative ideas and solutions by working closely with product development teams. Especially, experiencing hardships together was an essential factor to find and solve real problems.

Third, incorporating experiments and learnings to the team led to huge transformation not only our team but also other teams and our organization. We changed our urgent onboarding as the start of inventing Sebas Report by utilizing Learning Session and continuous experiments. Additionally, the effectiveness of Learning Session has been expanding throughout our company.

The key characteristic of we SET team is experimenting frequently and flexibly based on what we learned from global conferences like Agile20XX, articles, popular open-sourced tools, and so forth. Additionally, we are always aiming at contribution to our company and business. It's not too much to say that we are always pursuing "best for our users and business" fiercely and relentlessly with a series of experiments.

# WHAT'S NEXT?

Currently, we have been experimenting the following ideas for further improvements.

The first one is applying "Design Sprint" [21] for solving complicated technical problems at a brownfield product. In July 2019, one product development team which develops and operates one mature product contacted us to help improving their Test Automation activities. However, we soon found that they had been struggling with isolation of problems and disagreements on solutions among team members. To solve confusions and teach the team members how to overcome this situation, we started utilizing Design Sprint by working with the team. Design Sprint is basically for Product Management. However, we have been utilizing this idea for solving technical issues. We try new technical ideas and tools within 1-week. We gather feedbacks and decide whether to proceed the idea or switch to other one within this short cycle. We continue this inspection and adaptation cycle until solving problems. After these series of investigation cycles, the team has been simplifying their integration tests by adapting to Testcontainers [22] and improving hidden Slow Tests problem [23] by their own.

The second one is building and providing "Testable and Disposable Infrastructure" to product development teams to make testing easier without fear. Currently, our company doesn't have enough production-like test environments. It makes us hard to test enough to detect bugs and reproduce outages quickly without fear for operation miss and misconfiguration. It is becoming a huge barrier for testing. Therefore, we have been trying to build production-like test environments with Container and its orchestration mechanism with Docker [24] and Kubernetes [25]. We are aiming to provide a test environment which is easy to copy, destroy, and restore. We are inspired by the idea of Immutable infrastructure [26].

The third one is to scale out our activities. Now our team has only 4 members. As I explained earlier, we SET team ruled to work with target product development teams together as the first step. However, it is impractical to expand improvement company-wide with only 4 members. Therefore, we have been trying to find practitioners who are interested in Test Automation and Agile throughout the company, unite them by forming an informal team, and expand our activities with them together. We are considering to utilize the idea of "Guild" [27] at Spotify.

# CONCLUSIONS

There have been lots of problems. Microservice Architecture is useful for independent develop-ability and deployability, however, it tends to strengthen apathy toward other teams and services/products. Additionally, there are short of leaders who can find and solve problems beyond silos and teams. Moreover, quality assurance approach is not proper for solving outages of Microservices.

We SET team have been solving these problems as follows.

At first, we aim to overcome limitations of feature teams for Microservice Architecture. Many Agile enthusiasts and practitioners insist of the importance of a feature team rather than a component team. However, only applying for a feature team cannot tame Microservice Architecture. Therefore, SET team behaves to tie each product development team, service, and product with providing a whole image of business, and ways to test and recover each service.

Second, we train and nurture leaders who can find problems and solve them beyond teams and silos. LINE Corporation has lots of excellent software engineers. However, there are few leaders. Only technical excellence cannot tame complexity of Microservice Architecture and our business. SET team is effective for nurturing these leaders by utilizing both technical skills and Agile methodologies.

Third, we have been building and expanding tools, process improvements, and new KPIs to get over limitations of quality assurance. The combination of Karate framework and Sebas Report makes testing and recovering Microservices easier. Additionally, the idea of Build Quality In is becoming common for some services/products. Focusing on profitability and MTTR rather than the number of bug detection before releases works now in organizational performance and culture perspective.

SET is derived from Google. This role is responsible for enhancing productivity of engineers by utilizing test automation, automation infrastructure, and process improvements in Google. SET in LINE Corporation tried to start from this definition. However, we have been changing responsibilities continuously for pursuing contribution to our company's business performance. We have been expanding our responsibility from Test Automation to company-wide process improvements with continuous impacts to stakeholders.

Currently, we are transforming ourselves as a team of Transformational Leaders. SET team defined its philosophy as "WOW DX": the combination of "WOW", LINE Corporation’s action philosophy and mindset [23], and the Developer eXperience. We are pursuing a great Developer eXperience for all of product development team members and stakeholders in LINE Corporation with automation techniques and Agile methodologies. We continue to pursue improving all of our business relentlessly.

REFERENCESs

[1] LINE. https://linecorp.com/en/.

[2] Whittaker, J. Arbon, J., & Carollo, J. 2012. How Google Tests Software. Addison-Wesley Professional.

[3] LINE. https://linecorp.com/press/2013/0401472.

[4] Fowler, M. 2014. Microservices. https://martinfowler.com/articles/microservices.html.

[5] Nygard, M. 2018. Release It!: Design and Deploy Production-Ready Software 2nd Edition. Pragmatic Bookshelf.

[6] Hussman, D. 2015. Product Discovery On A Single Page. http://productdiscoverycanvas.com/tag/david-hussman/.

[7] SonarQube. https://www.sonarqube.org/.

[8] Whittaker, J. Arbon, J., & Carollo, J. 2012. How Google Tests Software. Addison-Wesley Professional.

[9] Whittaker, J. Arbon, J., & Carollo, J. 2012. How Google Tests Software. Addison-Wesley Professional.

[10] Slack. https://slack.com/.

[11] Spring Boot. https://spring.io/projects/spring-boot.

[12] Karate. https://github.com/intuit/karate.

[13] Apache Thrift. https://thrift.apache.org/.

[14] gRPC. https://grpc.io/.

[15] Cucumber. https://cucumber.io/docs/gherkin/.

[16] Agile Alliance. https://www.agilealliance.org/glossary/bdd/.

[17] Lucian, C. 2017. Growing the Mob. https://www.agilealliance.org/wp-content/uploads/2017/02/GrowingTheMob.pdf.

[18] LINE Engineering Blog. https://engineering.linecorp.com/ja/blog/recommend-learning-session/.

[19] Zipkin. https://zipkin.io/.

[20] Vue.js. https://vuejs.org/.

[21] GV. https://www.gv.com/sprint/.

[22] Testcontainers. https://www.testcontainers.org/.

[23] xUnit Patterns.com. http://xunitpatterns.com/Slow%20Tests.html.

[24] Docker. https://www.docker.com/.

[25] Kubernetes. https://kubernetes.io/.

[26] The Digitalocean Community. https://www.digitalocean.com/community/tutorials/what-is-immutable-infrastructure.

[27] Kniberg, H., & Ivarsson, A. 2012. Scaling Agile @ Spotify with Tribes, Squads, Chapters & Guilds. https://blog.crisp.se/wp-content/uploads/2012/11/SpotifyScaling.pdf.